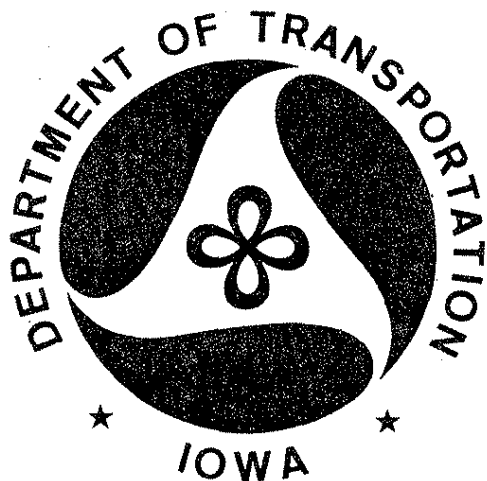


IOWA PORE INDEX TEST

Interim Report



Highway Division
Office of Materials
January 1980

INTERIM REPORT

IOWA

PORE INDEX

TEST

BY

JAMES D. MYERS
CHIEF GEOLOGIST
515/296-1339

AND

WENDELL DUBBERKE
GEOLOGIST

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
OFFICE OF MATERIALS
GEOLOGY SECTION
AMES, IOWA 50010

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IOWA PORE INDEX TEST

INTRODUCTION

The D-cracking of portland cement concrete pavements in Iowa was first recognized as a problem nearly 20 years ago. Early investigations revealed that the D-cracking was primarily associated with the use of limestone coarse aggregates that were susceptible to freeze-thaw failure, but that susceptibility could not be identified by any of the usual aggregate tests.

In 1962 research began into the freeze-thaw testing of aggregate in concrete. The procedure used was similar to that described by ASTM C-291.¹ After several years of investigation proved the reliability of this type of testing, the 1972 Iowa Standard Specifications required its use to determine the D-cracking susceptibility of limestone aggregates that lacked reliable service records.

While the freeze-thaw testing of aggregate in concrete has proven to be satisfactory in identifying limestone aggregates that can cause D-cracking, the procedure (modified ASTM C-666, Method B) does have undesirable features. The natural variability in the limestone sources associated with D-cracking is such that some samples will perform well when tested. Concrete beams containing aggregate with satisfactory service records can fail if minor amounts of deleterious materials are present in the aggregate. Also, a very long time--five to six months--is required to complete the test. A considerable part of that time, 90 days, is required for a moist-room cure. Iowa historically uses a moist room cure for concrete specimens and shorter cure times did not provide ranges of either growth or sonic modulus sufficient to differentiate between aggregates that do and do not cause D-cracking. In an effort to develop a shorter, more efficient test, Wendell Dubberke, a geologist with the Office of Materials, began investigations into measuring the amounts of water, under low air pressure, that could be injected into oven-dried aggregate.

OBJECTIVE

The objective of the investigations was the development of a test that would readily identify the potential of an aggregate to cause D-cracking because of its susceptibility to critical saturation.

DEVELOPMENT OF THE PORE INDEX TEST

A Press-Ur-Meter was modified by replacing the air chamber with a one-inch diameter plastic tube calibrated in milli-

¹This test procedure is now designated as ASTM C-666, Method B.

liters. Oven-dried aggregate, cooled to room temperature, was placed in the container and covered with tap water to the zero mark in the plastic tube. Air pressure at 35 psi was introduced through the top of the plastic tube. A brief interval at the start of the test used to fill the larger void spaces in the stone, was termed the "primary load". The amount of water forced into the aggregate in the remainder of the test was termed "secondary load".

The primary-load measurements had no relationship to the susceptibility to D-cracking of aggregates with established service records. It was noted, however, that a few poor-quality aggregates with high primary-load measurements tend to perform well on the concrete durability test (ASTM C666, Method B), raising doubts of the validity of the test on highly porous aggregate.

High secondary-load measurements appeared to identify those aggregates associated with the D-cracking of portland cement concrete pavements. All subsequent investigation was therefore concerned only with the secondary-load measurements.

Equipment and procedural modifications continued to be made until those described in Appendix A were finally adopted.

PORE-INDEX TESTING

Routine aggregate testing was performed for the first time in 1978. All samples of coarse aggregate for use in portland cement concrete received by the Materials Laboratory were tested. Because D-cracking aggregates are restricted to a 3/4" maximum size, all pore-index samples were limited to the 1/2" x 3/4" particle sizes.

The quality specifications for coarse aggregate for portland cement concrete require that it have a freeze-thaw loss of six percent or less on Iowa Test Method No. 211. This is a water-alcohol test similar to AASHTO T 103, Procedure B. Because this test is quite severe on limestone aggregates with acid-insoluble material of clay and silt size, nearly all of the limestone samples tested had acid-insoluble contents of approximately six percent or less.

The results of the 1978 testing are given in Appendix B. The listing is in order by county number. Out-of-state sources are listed first. The last column headed "SERV" contains a number denoting the durability class of the source. A "1" indicates a Class 1 (D-cracking) durability source. A "2" or "3" indicates a Class 2 (satisfactory) durability source. Those listings with no number in this column are informational samples from unapproved sources.

Test Results on Aggregate with Service Record

Samples were received from 28 sources with 10 or more years of service record. Most had service records of twenty years or more. A secondary load of 27 milliliters is currently used to separate sources of aggregate associated with D-cracking from those that have satisfactory service records.

All 28 of these sources with established service records had secondary loads of 27 or less on all those not associated with D-cracking and above 27 on those that are associated with D-cracking. All of the D-cracking sources were sufficiently homogenous that no test results of 27 or less were obtained. Composite samples can be a problem and the individual stone types should be tested separately when necessary.

Test Results on Aggregate without Service Record

Tests run on aggregate from the remainder of the approved sources had 10 or fewer years of established service as coarse aggregate in portland cement concrete.

As can be seen in Appendix B some pore-index results were contrary to the approved durability classes.

These were, in order of appearance, by quarry name:

Lemley. This Class 1 (D-cracking) source had good pore-index test results. This is a new source. Other Exline sources cause D-cracking. However, concrete beams containing this aggregate also indicate that a better durability rating is justified.

Kruse. The listing is in error. This is a Class 2 durability source consistent with the pore-index test results.

Hibness. Two of nine pore-index results are contrary to the durability class rating.

Hodges-Dakota City. The durability class rating was originally established by testing of concrete beams. More recent results are consistent with the pore-index testing, indicating that this is a source of variable durability that may require more testing before additional use.

Klein. The two contradictory pore-index test results were due to the samples containing material from unapproved beds below the concrete ledge.

Ollie. The approved concrete ledge at this quarry, because of the pore-index test noted, was sampled bed by bed. A poor zone was identified and a new Class 2 durability ledge approved.

Early Chapel. Three test results on samples from this quarry are contradictory to the durability class rating. This is to be expected since the source is variable in nature. ASTM C666, Method B results are also variable.

Durham. The approved ledge at this quarry contains beds of widely disparate character. They need to be individually assessed before additional use.

Ferguson. This is a heavily-used, established source with a recently approved ledge of lower quality. The ledge with the established satisfactory service record contains some alkali-reactive material and frequently fails freeze-thaw, ASTM C666 Method B, and these pore-index tests. Additional beds have recently been added to those that had been originally approved. This source would never have been approved under any of the presently used criteria. However, it has a satisfactory service record of more than 20 years on the old ledge with the poor material.

Northwood. This source has five pore-index test results contrary to its durability rating. Several of these were taken to verify aggregate quantities containing material from unapproved beds.

CONCLUSIONS

The pore index test was sufficiently reliable to determine the D-cracking potential of limestone aggregates in all but a few cases where marginal results were obtained. Consistently poor or good results were always in agreement with established service records or concrete durability testing.

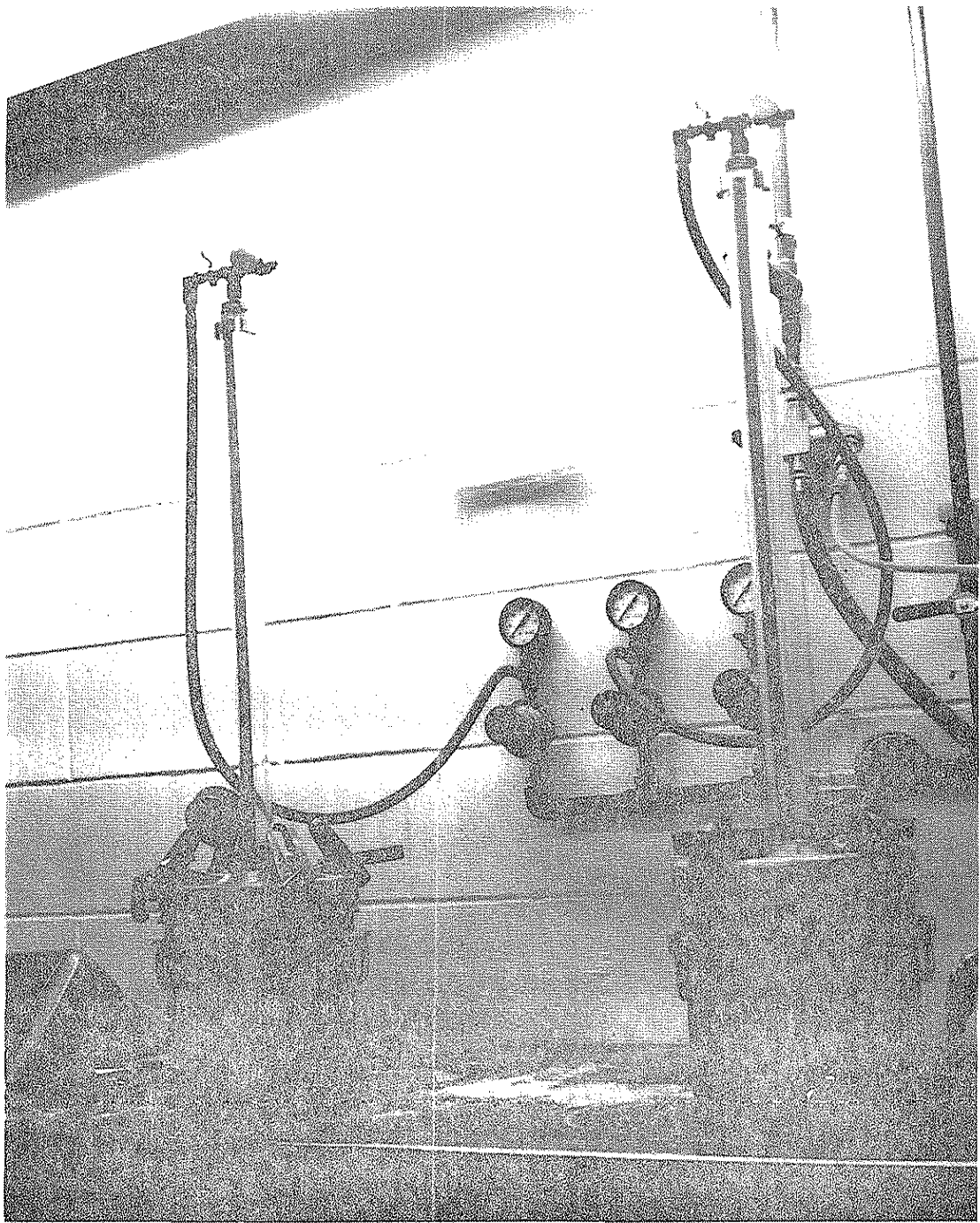
In those instances where marginal results are obtained the results of concrete durability testing should be considered when making the final determination of the D-cracking susceptibility of the aggregate in question.

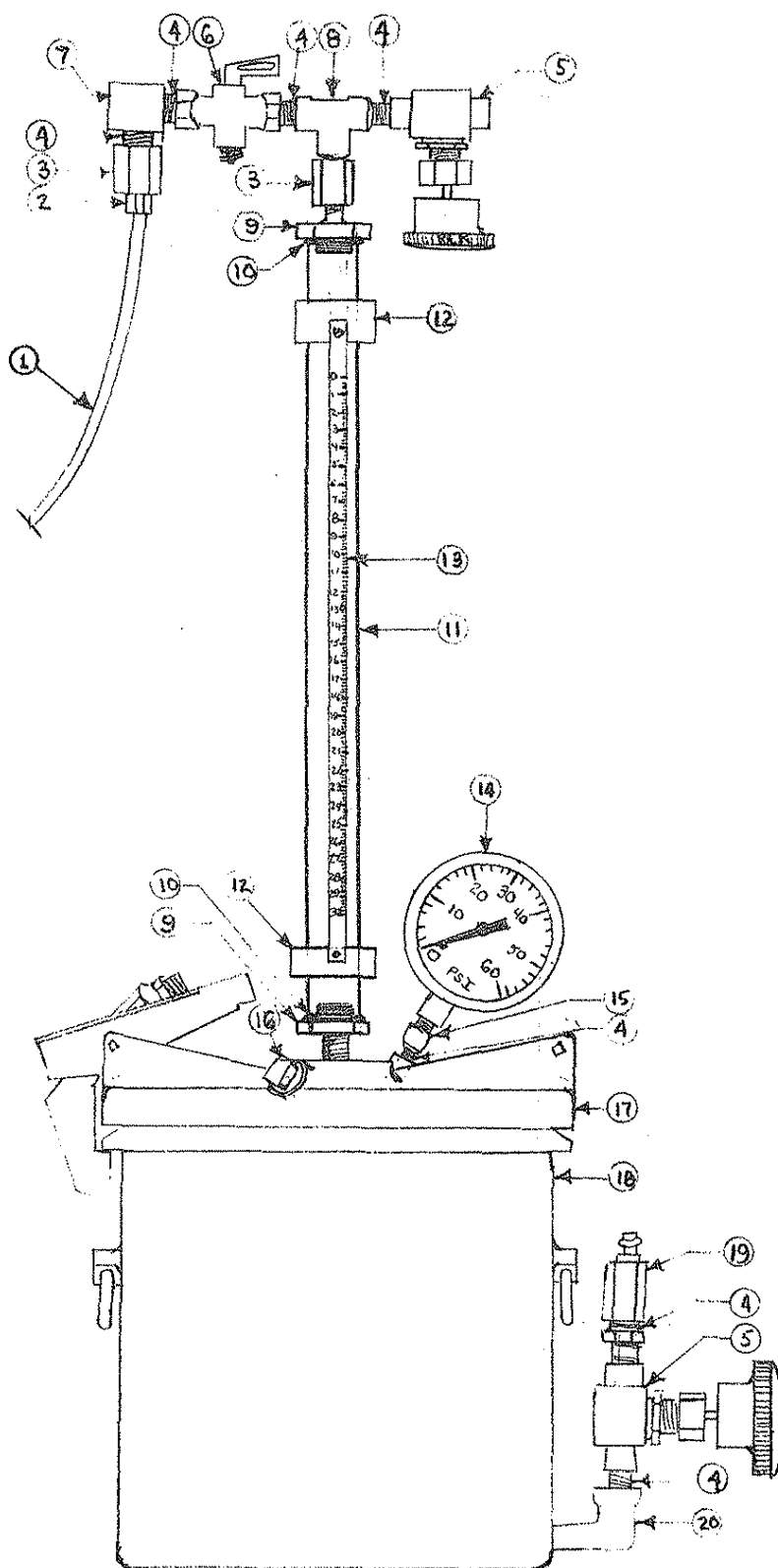
RECOMMENDATIONS

The following applications for the pore index test have been recommended for consideration:

1. Concrete durability testing be discontinued in the evaluation process of new aggregate sources with pore index results between 0-20 (Class 2 durability) and over 35 (Class 1 durability).
2. Composite aggregates with intermediate pore index results of 20-35 be tested on each stone type to facilitate the possible removal of low durability stone from the production process.
3. Additional investigation should be made to evaluate the possibility of using the test to monitor and upgrade the acceptance of aggregate from sources associated with D-cracking.

APPENDIX A
PORE INDEX TEST APPARATUS AND PROCEDURES





1. Rubber Air Hose
2. Brass Hose Connector
3. Brass Nut - 2
4. 3/4"-3/8" Pipe Nipples-7
5. 3/8" Pipe Size Needle Valve-2
6. 3/8" Shutoff Cock
7. 3/8"-90° Brass Block Pipe Elbow
8. 3/8" Tee
9. Hex Reducing Nipple 3/8" x 1" -2
10. O-Ring 1"-2
11. 26" - 1" Inside Dia. Plexiglass Pipe-1/4" Walls
12. Broom Hanger Clips-2
13. Brass Scale - Graduated from 0-30 at 1 unit equal to 3/4" - subdivided to 0.2 increments..
14. Pressure Gauge capable of up to 60 P.S.I.
15. 3/8" x 1/2" Pipe Reducer
16. 3/8" Pipe Plug
17. 1 Air Meter Lid conforming to AASHTO T152 with Air Pump and Shutoff Cocks removed
18. Air Meter Bowl with bored and tapped 3/8" hole at bottom.
19. 3/8" MPT Plug - for quick connect water hose coupling.
20. 3/8" - 90° Street Elbow

NOT DRAWN TO SCALE

(3 Hold-down clamps
not shown)

Pore Index Test Apparatus and Procedures

Test Unit Apparatus

A modified Press-ur-meter is used to perform the pore index test. The pump, valve and gauge were removed from the lid and replaced by a 320 milliliter plexiglas tube, graduated in two milliliter increments. The addition of a standard 60 psi pressure gauge completes the lid modifications. A hole was drilled through the side of the pot at the bottom, fitted with a valve, and is used for loading and unloading the pot with cold tap water. Two valves are located at the top of the plexiglas tube. One valve is connected to a line supplying air at a constant 35 psi. The other valve is a vent valve and is opened while charging the unit with water.

Test Procedure

1. Place 9000* grams of oven dried, 1/2x3/4 inch aggregate in the pot.
2. Attach the lid, open the vent valve, and fill the pot and plexiglas tube with cold tap water to the "0" milliliter mark. The pressure gauge on the lid must remain at the zero P.S.I. mark during this filling stage.
3. Close the water supply and vent valves and then open the 35 PSI air supply valve as soon as possible. The air valve remains open throughout the duration of the test.
4. Take a water level reading at one minute. The amount of water injected during this first minute fills the aggregate's macro-pores and is referred to as the primary load.

A large primary load is considered to be an indication of a beneficial limestone property. A well developed macro-pore system probably functions in a manner similar to air entrainment voids in concrete paste. The primary load is not used in the pore index test result calculations.

5. Take a water level reading at fifteen minutes. The volume of water injected between one minute and fifteen minutes is the secondary load and represents the amount of water injected into the aggregate's micro-pore system. A secondary load of 27 milliliters or more indicates a negative limestone property that correlates with a saturated aggregate's inability to withstand internal pressures caused by freezing. The secondary load in milliliters is reported out as the final pore index test result.

*During the evaluation phase of the Pore-Index test, samples ranging from 3000 to 10,000 grams were accepted for testing. Since the secondary load (Pore Index test result) is directly proportional to the size of the sample, we computer adjusted the test results to reflect a projected 9000 gram sample. Many of the adjusted test results were from short samples received from the districts but in a few cases we were forced to use a half sample because some high absorption, full samples, exceeded the capacity of the 320 milliliter tube during the primary load phase of the test.

APPENDIX B

PORE INDEX TEST RESULTS BY QUARRY

GRAPH OF PORE INDEX 14.0 MINUTE LOAD FROM 01 MIN TO 15 MIN
IN SEQUENCE BY PORE INDEX WITHIN QUARRY WITHIN COUNTY
WENDELL DUBBERKE 1-515-276-1339 IOWA DOT AMES, IOWA

16:57 MONDAY, JANUARY 14, 1980

LABNO	QUARRY	CO	UNIT	00	10	20	30	40	50	60	70	80	SIZE/BED/SERV
C9796	WYONDOT OH	0	SILURIAN	*****	.								1/2 3
C9828	TYRONE(KY)	0		*****	.								1/2 ?
C9827	LITERS(KY)	0		*****	.								1/2 ?
C9797	WATERVILLE	0	SILURIAN	*****	.								1/2 ?
C8068	MINN CR PC	0	CRUSHED PC	*****	.								1/2 ?
C8888	BIGGSVILLE	0	BURLINGTON	*****	.								1/2 6
C8602	BIGGSVILLE	0	BURLINGTON	*****	.								1/2 3
C8603	BIGGSVILLE	0	BURLINGTON	*****	.								1/2 3
C8097	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8945	BIGGSVILLE	0	BURLINGTON	*****	.								1/2 3
C8634	BIGGSVILLE	0	BURLINGTON	*****	.								1/2 3
C8106	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8377	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8099	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C9002	DALLAS CTY	0	BURLINGTON	*****	.								1/2 3
C8270	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8633	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8265	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8523	PR DUCHIEN	0	GRAVEL TOT	*****	.								1/2 3
C8692	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8626	WEEPING W	0	PLATTSMT	*****	.								1/2 10
C8697	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8796	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8644	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8841	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8690	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8399	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8643	WEEPING W	0	PLATTSMT	*****	.								1/2 3
C8931	JEFFERIES	0	BETH FALLS	*****	.								1/2 2-8
C8877	DALLAS CTY	0	BURLINGTON	*****	.								1/2 5-6
C8876	DALLAS CTY	0	BURLINGTON	*****	.								1/2 5-6
C8686	MENLO	1	ARGENTINE	*****	.								1/2 1
C8275	MENLO	1	ARGENTINE	*****	.								1/2 1
C8227	MENLO	1	ARGENTINE	*****	.								1/2 1
C8175	MENLO	1	ARGENTINE	*****	.								1/2 1
C8246	MENLO	1	ARGENTINE	*****	.								1/2 1
C8920	MENLO	1	ARGENTINE	*****	.								1/2 15AC
C8320	MENLO	1	ARGENTINE	*****	.								1/2 1
C8624	MENLO	1	ARGENTINE	*****	.								1/2 1
C8248	MENLO	1	ARGENTINE	*****	.								1/2 1
C8438	MENLO	1	ARGENTINE	*****	.								1/2 1
C8437	MENLO	1	ARGENTINE	*****	.								1/2 1
C8646	MENLO	1	ARGENTINE	*****	.								1/2 1
C8415	MENLO	1	ARGENTINE	*****	.								1/2 1
C8919	MENLO	1	ARGENTINE	*****	.								1/2 1
C8769	MENLO	1	ARGENTINE	*****	.								1/2 1
C8524	MENLO	1	ARGENTINE	*****	.								1/2 1

16:57 MONDAY, JANUARY 14, 1980 ³

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16:57 MONDAY, JANUARY 14, 1980

WENDELL DUBBERKE 1-515-296-1339 IOWA DOT AMES, IOWA

LABNO	QUARRY	CO	UNIT	00	10	20	30	40	50	60	70	80	SIZE/BED/SERV
C8570	MCGUIRE	16	GOWER	*****									1/2 3
C8675	MCGUIRE	16	GOWER	*****									1/2 3
C8457	QUIMBY	17	CORALVILLE	*****									1/2 3
C8875	QUIMBY	17	CORALVILLE	*****									1/2
C8775	QUIMBY	17	CORALVILLE	*****									1/2
C9599	QUIMBY	17	CORALVILLE	*****									1/2 5-10 3
C9700	QUIMBY	17	CORALVILLE	*****									1/2 5-10 3
C8533	QUIMBY	17	CORALVILLE	*****									1/2 3
C9343	KOHLER #1	17	CORALVILLE	*****									1/2 1-8 3
C9343	KOHLER #2	17	CORALVILLE	*****									1/2 1-8 3
C8599	LILLYBRIDGE	17	OWEN	*****									1/2 3
C8078	NASHUA	19	CORALVILLE	*****									1/2 2
C8230	NASHUA	19	CORALVILLE	*****									1/2 2
C8117	NASHUA	19	CORALVILLE	*****									1/2 2
C8137	NASHUA	19	CORALVILLE	*****									1/2 2
C9745	NASHUA	19	CORALVILLE	*****									1/2 9-10 3
C9746	NASHUA	19	CORALVILLE	*****									1/2 9-10 3
C9744	NASHUA COM	19	CORALVILLE	*****									1/2 9-10 3
C8442	NASHUA S	19	CORALVILLE	*****									1/2 3
C8441	NASHUA N	19	CORALVILLE	*****									1/2 3
C8439	NASHUA E	19	CORALVILLE	*****									1/2 3
C8440	NASHUA W	19	CORALVILLE	*****									1/2 3
C8315	TWIN ROCKS	22	STEWARTVLE	*****									1/2 2
C7000	BENTE-S	22	STEWARTVLE	*****									1/2 4-9 2
C7000	BENTE	22	STEWARTVLE	*****									1/2 4-9 2
C7000	BENTE	22	STEWARTVLE	*****									1/2 4-9 2
C7000	BENTE-N	22	STEWARTVLE	*****									1/2 4-9 2
C8373	KRUSE	22	STEWARTVLE	*****									1/2 5-11
C8573	KRUSE	22	STEWARTVLE	*****									1/2 5-12 3
C8705	KRUSE	22	STEWARTVLE	*****									1/2 1
C8754	KRUSE	22	STEWARTVLE	*****									1/2 3
C8706	KRUSE	22	STEWARTVLE	*****									1/2 1
C8706	KRUSE	22	STEWARTVLE	*****									1/2 1
C8529	KRUSE	22	STEWARTVLE	*****									1/2 3
C9011	KRUSE	22	STEWARTVLE	*****									1/2 2
C8786	KRUSE	22	STEWARTVLE	*****									1/2
C9272	KRUSE	22	STEWARTVLE	*****									1/2 5-12 3
C8572	KRUSE	22	STEWARTVLE	*****									1/2 3
C8177	MORAREND	22	STEWARTVLE	*****									1/2 3
C7662	JOY SPRING	22	HOPKINTON	*****									1/2 1-3 3
C7000	BENTE PIT	22	GRAVEL TOT	*****									1/2 1

5
11:57 MONDAY, JANUARY 14, 1980

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16:57 MONDAY, JANUARY 14, 1980

[illegible]

GRAPH OF PORE INDEX 14.3 MINUTE LOAD FROM 01 MIN TO 15 MIN
IN SEQUENCE BY PORE INDEX WITHIN QUARRY WITHIN COUNTY
WENDELL DUBBERKE 1-515-296-1339 IOWA DOT AMES, IOWA

16:57 MONDAY, JANUARY 14, 1980 7

LABNO QUARRY CO UNIT 00 10 20 30 40 50 60 70 80 SIZE/RED/SERV

C6700	LOGAN	CLRK	43	BETH FALLS	*****	1/2	1
C8120	LOGAN	CLK	43	BETH FALLS	*****	1/2	1
C8350	LOGAN		43	BETH FALLS	*****	1/2	1
C8699	LOGAN		43	BETH FALLS	*****	1/2	1
C8517	LOGAN		43	BETH FALLS	*****	1/2	1
C8567	LOGAN		43	BETH FALLS	*****	1/2	1
C8833	LOGAN		43	BETH FALLS	*****	1/2	1

C6389	SARATOGA	N	45	HOPKINTON	*****	1/2	829 3
C6385	SARATOGA	S	45	HOPKINTON	*****	1/2	829 3
C8485	SARATOGA	E	45	SOLON	*****	1/2	1-3 3
C8386	SARATOGA	E	45	HOPKINTON	*****	1/2	829 3
C6387	SARATOGA	W	45	HOPKINTON	*****	1/2	829 3
C6487	SARATOGA		45	SOLON	*****	1/2	1-3 3
C8488	SARATOGA	S	45	SOLON	*****	1/2	1-3 3
C8486	SARATOGA		45	SOLON	*****	1/2	1-3 3

C6317	DOTZLER		45	HOPKINTON	*****	1/2	3
C8236	DALEY		45	HOPKINTON	*****	1/2	3
C8206	DALEY		45	HOPKINTON	*****	1/2	3
C8234	DALEY		45	HOPKINTON	*****	1/2	3
C8316	DALEY		45	HOPKINTON	*****	1/2	3
C8238	DALEY		45	HOPKINTON	*****	1/2	3

C8190	SOUHRADA		45	SOLON	*****	1/2	3
C8185	SOUHRADA		45	SOLON	*****	1/2	3
C8141	SOUHRADA		45	SOLON	*****	1/2	3
C8239	SOUHRADA		45	SOLON	*****	1/2	3

C8475	KAMPEN		46	GIL CITY	*****	1/2	3
C8171	KAMPEN		46	GIL CITY	*****	1/2	3
C8075	KAMPEN		46	GIL CITY	*****	1/2	3

C8412	HODGES		46	GIL CITY	*****	1/2	2
C8396	DAKOTA	CTY	46	GIL CITY	*****	1/2	
C8698	HODGES		46	GIL CITY	*****	1/2	10-18
C8538	HODGES	E	46	GIL CITY	*****	1/2	10-18 3

C8149	ANDREW		49	HOPKINTON	*****	1/2	3
C8299	ANDREW		49	HOPKINTON	*****	1/2	3

C8261	PRESTON		49	HOPKINTON	*****	1/2	7-10 3
C8616	PRESTON		49	HOPKINTON	*****	1/2	
C8821	PRESTON		49	HOPKINTON	*****	1/2	3

C8632	CONKLIN		52	CORALVILLE	*****	1/2	3
C9008	CONKLIN		52	CORALVILLE	*****	1/2	3
C8594	CONKLIN		52	CORALVILLE	*****	1/2	3
C8677	CONKLIN		52	CORALVILLE	*****	1/2	3

14:57 MONDAY, JANUARY 14, 1980.

LABNO	QUARRY	CO UNIT	00	10	20	30	40	50	60	70	80	SIZE/BED/SERV
C8134	KLEIN	52	CORALVILLE	*****								1/2 3
C8094	KLEIN	52	CORALVILLE	*****								1/2 3
C8101	KLEIN	52	CORALVILLE	*****								1/2 3
C8336	KLEIN	52	CORALVILLE	*****								1/2 3
C8028	KLEIN	52	CORALVILLE	*****								1/2 3
C8027	KLEIN	52	CORALVILLE	*****								1/2 3
C8125	FARMERS	53	GOWER	*****								1/2 3
C8742	FARMERS	53	GOWER	*****								1/2 3
C8583	BALLOU	53	GOWER	*****								1/2 3
C8723	BALLOU	53	GOWER	*****								1/2 3
C8748	BALLOU	53	GOWER	*****								1/2 3
C8767	STONE CITY	53	GOWER	****								1/2 3
C8337	STONE CITY	53	GOWER	****								1/2 3
C4009	STONE CTY	53	GOWER	*****								1/2 3
C8029	OLLIE	54	EAGLE CITY	*****								1/2 2
C9053	OLLIE	54	EAGLE CITY	*****								1/2 27-29 3
C8163	OLLIE	54	EAGLE CITY	*****								1/2 ?
C8463	OLLIE	54	EAGLE CITY	*****								1/2 ?
C8463	OLLIE	54	EAGLE CITY	*****								1/2
C9132	OLLIE CRT	54	EAGLE CITY	*****								1/2 CHERT 1
C8262	BOWSER	57	GOWER	***								1/2 3
C8287	BOWSER	57	GOWER	*****								1/2 3
C8850	BOWSER	57	GOWER	*****								1/2 b-7
C8827	BOWSER	57	GOWER	*****								1/2 b-7
C8756	CDR RPD S	57	GOWER	*****								1/2 3
C8571	CDR RPD S	57	GOWER	*****								1/2 3
C8200	CDR RAP S	57	GOWER	*****								1/2 3
C8201	CDR RPD S	57	GOWER	*****								1/2 3
C8205	CDR RAP S	57	GOWER	*****								1/2 3
C8612	CDR RPD S	57	GOWER	*****								1/2 3
C8757	CDR RPD S	57	GOWER	*****								1/2 3
C8739	CDR RPD S	57	GOWER	*****								1/2 3
C8539	CDR RPD S	57	GOWER	*****								1/2 3
C8365	CDR RAP S	57	GOWER	*****								1/2 3
C8560	CDR RPD S	57	GOWER	*****								1/2
C8867	LISBON	57	GOWER	*****								1/2 3
C8064	COL JCT	58	WASSONVLE	*****								1/2 3
C8092	COL JCT	58	WASSONVLE	*****								1/2 3
C8092	COL JCT	58	WASSONVLE	*****								1/2 3
C8620	COL JCT	58	WASSONVLE	*****								1/2 3
C8713	COL JCT	58	WASSONVLE	*****								1/2 3
C8810	COLUMBUS JT	58	WASSONVLE	*****								

GRAPH OF PORE INDEX 14.0 MINUTE LOAD FROM 01 MIN TO 15 MIN
IN SEQUENCE BY PORE INDEX WITHIN QUARRY WITHIN COUNTY
WENDELL DUBBERKE 1-515-296-1339 IOWA DOT AMES, IOWA

16:57 MONDAY, JANUARY 14, 1980

LAB NO	QUARRY	CO	UNIT	DO	10	20	30	40	50	60	70	80	SIZE/BED/SERV
C8176	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8198	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8336	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8277	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8936	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8656	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8919	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8673	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8264	EARLY CHAP	61	ARGENTINE	*****	.								1/2 1
C8933	EARLY CHAP	61	ARGENTINE	*****	.								1/2 15-A C
C8933	EARLY CHAP	61	ARGENTINE	*****	.								1/2 15A-C
C8672	EARLHAM	61	ARGENTINE	*****	.								1/2 1
C8942	EYERLY	61	ARGENTINE	*****	.								1/2 1
C8938	EYERLY	61	ARGENTINE	*****	.								1/2 1
C8939	EYERLY	61	ARGENTINE	*****	.								1/2 15-A C
C8941	EYERLY	61	ARGENTINE	*****	.								1/2 15-A C
C8061	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8164	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8209	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8159	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8762	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8763	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8335	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8158	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8165	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8448	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8293	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8333	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8290	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8082	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8607	DURHAM	63	EAGLE CITY	*****	.								1/2 3
C8578	FERGUSON	64	EAGLE CITY	*****	.								1/2 2-7 ?
C7800	FERGUSON	64	EAGLE CITY	*****	.								1/2 1-18 3
C8747	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8518	FERGUSON	64	EAGLE CITY	*****	.								1/2 8-17 3
C8830	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8197	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8135	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8611	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8157	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8568	FERGUSON	64	EAGLE CITY	*****	.								1/2 8-17 3
C8577	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8534	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8516	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8601	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8927	FERGUSON	64	EAGLE CITY	*****	.								1/2 1-17
C8926	FERGUSON	64	WASSONVLE	*****	.								1/2 1-7
C8253	FERGUSON	64	EAGLE CITY	*****	.								1/2 3

GRAPH OF PORE INDEX 14.0 MINUTE LOAD FROM 01 MIN TO 15 MIN
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WENDELL DUBBERKE 1-515-296-1339 IOWA DOT AMES, IOWA

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LABNO	QUARRY	CO	UNIT	00	10	20	30	40	50	60	70	80	SIZE/BED/SERV
C8273	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8104	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8642	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C7000	FERGUSON	64	EAGLE CITY	*****	.								1/2 1-18 3
C8730	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8930	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8928	FERGUSON	64	EAGLE CITY	*****	.								1/2 1-17 3
C8710	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C7000	FERGUSON S	64	EAGLE CITY	*****	.								1/2 1-18 3
C8295	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8844	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C7000	FERGUSON E	64	EAGLE CITY	*****	.								1/2 1-18 3
C8839	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8334	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8647	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C7000	FERGUSON N	64	EAGLE CITY	*****	.								1/2 1-18 3
C7000	FERGUSON N	64	EAGLE CITY	*****	.								1/2 1-18 3
C7000	FERGUSON E	64	EAGLE CITY	*****	.								1/2 1-18 3
C7000	FERGUSON W	64	EAGLE CITY	*****	.								1/2 1-18 3
C8547	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8095	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8289	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8455	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8894	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8940	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8155	FERGUSON	64	EAGLE CITY	*****	.								1/2 3
C8063	DUENOW	66	CORALVILLE	*****	.								1/2 3
C8598	DUENOW	66	CORALVILLE	*****	.								1/2 3
C8669	DUENOW	66	CORALVILLE	*****	.								1/2 3
C8079	DUENOW	66	CORALVILLE	*****	.								1/2 3
C8413	DUENOW	66	CORALVILLE	*****	.								1/2 3
C8411	DUENOW	66	CORALVILLE	*****	.								1/2 3
C8670	LESCH	66	CORALVILLE	*****	.								1/2 ?
C8929	STENNETT	69	SPRING BR	*****	.								1/2 7-7 *
C8925	MOSCOW	70	WAPSI	*****	.								1/2 3
C8635	MOSCOW	70	WAPSI	*****	.								1/2 3
C8913	MOSCOW	70	WAPSI	*****	.								1/2 11-15 3
C8291	MOSCOW	70	WAPSI	*****	.								1/2 3
C8166	MOSCOW	70	WAPSI	*****	.								1/2 3
C8682	MOSCOW	70	WAPSI	*****	.								1/2 3
C8682	MOSCOW	70	WAPSI	*****	.								1/2 3
C8811	MOSCOW	70	WAPSI	*****	.								1/2 3
C8878	MOSCOW	70	WAPSI	*****	.								1/2 3
C8105	GIL CTY H	76	GIL CITY	*****	.								1/2 3
C8169	GIL CTY H	76	GIL CITY	*****	.								1/2 3
C8148	GIL CTY H	76	GIL CITY	*****	.								1/2 3
C8648	GIL CTY H	76	GIL CITY	*****	.								1/2 3

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LABNO	QUARRY	CO UNIT	00	10	20	30	40	50	60	70	80	SIZE/BED/SERV
C8626	GIL CTY H	76	GIL CITY	*****								1/2 3
C8401	GIL CTY H	76	GIL CITY	*****								1/2 3
C8782	GIL CTY H	76	GIL CITY	*****								1/2 1-3 3
C8702	GIL CTY H	76	GIL CITY	*****								1/2 3
C8269	GIL CTY H	76	GIL CITY	*****								1/2 3
C8466	GIL CTY H	76	GIL CITY	*****								1/2 W 3
C9731	GILMORE CY	76	GIL CITY	*****								1/2 1-3 3
C8468	GIL CTY H	76	GIL CITY	*****								1/2 S 3
C8697	GIL CTY	76	GIL CITY	*****								1/2 1-3 3
C8465	GIL CTY H	76	GIL CITY	*****								1/2 E 3
C8473	GIL CTY H	76	GIL CITY	*****								1/2 3
C8467	GIL CTY H	76	GIL CITY	*****								1/2 N 3
C8212	GIL CTY H	76	GIL CITY	*****								1/2 3
C8890	GIL CTY	76	GIL CITY	*****								1/2 1-5
C8637	GIL CTY	76	GIL CITY	*****								1/2 3
C8170	GIL CTY MW	76	GIL CITY	*****								1/2 3
C8627	GIL CTY MW	76	GIL CITY	*****								1/2 3
C8670	GIL CTY MW	76	GIL CITY	*****								1/2 3
C8869	GIL CTY	76	GIL CITY	*****								1/2 1-5
C9062	CRESCENT	78	BETH FALLS	*****								1/2 1
C8685	CRESCENT	78	BETH FALLS	*****								1/2 1
C8687	CRESCENT	78	BETH FALLS	*****								1/2 1
C8696	CRESCENT	78	BETH FALLS	*****								1/2 1
C8689	CRESCENT	78	BETH FALLS	*****								1/2 1
C8414	MALCOM	79	EAGLE CITY	*****								1/2 3
C8817	MALCOM	79	EAGLE CITY	*****								1/2 3
C8776	MALCOM	79	EAGLE CITY	*****								1/2 10C13 3
C8119	MALCOM	79	EAGLE CITY	*****								1/2 3
C8709	MALCOM	79	EAGLE CITY	*****								1/2 3
C8089	MALCOM	79	EAGLE CITY	*****								1/2 3
C8519	MALCOM	79	EAGLE CITY	*****								1/2 3
C8674	MCCAUSLAND	82	GOWER	*****								1/2 3
C8593	LE CLAIRE	82	GOWER	**								1/2 3
C8038	LECLAIRE	82	GOWER	*****								1/2 3
C8630	LECLAIRE	82	GOWER	*****								1/2 3
C8360	LECLAIRE	82	GOWER	*****								1/2 3
C8547	LECLAIRE	82	GOWER	*****								1/2 3-5
C8069	LECLAIRE	82	GOWER	*****								1/2 3
C8127	BUFFALO	82	WAPSI	*****								1/2 3
C8525	LINWOOD	82	WAPSI	*****								1/2 3
C9007	LINWOOD	82	WAPSI	*****								1/2 3
C9039	AMES MINE	85	GIL CITY	*****								1/2 3
C9036	AMES MINE	85	GIL CITY	*****								1/2 3
C9035	AMES MINE	85	GIL CITY	*****								1/2 3
C8772	AMES MINE	85	GIL CITY	*****								1/2 3

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SIZE/BED/SERV

UNIT	TYPE	MODEL	YEAR	MAKE	DESCRIPTION	STATUS	DATE	TIME
C8214	MONTOUR	86	CHAPIN	*****			1/2	3
C8025	MONTOUR	86	CHAPIN	*****			1/2	3
C9022	CRUSHED PC	87	CRUSHED PC	*****			1/2	2
C9022	CRUSHED PC	87	CRUSHED PC	*****			1/2	2
C8250	DOUDS	89	SPERGEN	*****			1/2	3
C8526	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8346	DOUDS	89	SPERGEN	*****			1/2	LOALS
C8502	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8459	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8330	DOUDS	89	SPERGEN	*****			1/2	3
C8750	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8527	DOUDS MINE	89	SPERGEN	*****			1/2	3
C9010	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8709	DOUDS	89	SPERGEN	*****			1/2	2
C8331	DOUDS	89	SPERGEN	*****			1/2	3
C8535	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8160	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8453	DOUDS	89	SPERGEN	*****			1/2	3
C8751	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8536	DOUDS MINE	89	SPERGEN	*****			1/2	3
C8161	DOUDS	89	SPERGEN	*****			1/2	3
C8251	DOUDS	89	SPERGEN	*****			1/2	3
C8294	DOUDS	89	SPERGEN	*****			1/2	3
C8448	DOUDS	89	SPERGEN	*****			1/2	3
C8096	DOUDS	89	SPERGEN	*****			1/2	3
C8042	DOUDS	89	SPERGEN	*****			1/2	3
C9570	FARMINGTON	89	ST GEN	*****			1/2	3A-3E 3
C9357	FARMINGTON	89	ST GEN	*****			1/2	3A-3E 3
C6777	FARMINGTON	89	ST GEN	*****			1/2	3A-G
C8030	FARMINGTON	89	ST GEN	*****			1/2	3
C8766	FARMINGTON	89	ST GEN	*****			1/2	3G 2
C8122	WESTCHESTR	92	BURLINGTON	****			1/2	3
C8167	WESTCHESTR	92	BURLINGTON	****			1/2	3
C8213	FT DODGE	94	GIL CITY	*****			1/2	3
C8146	FT DODGE	94	GIL CITY	*****			1/2	3
C8426	FT DODGE W	94	GIL CITY	*****			1/2	3
C8656	FT DODGE	94	GIL CITY	*****			1/2	3
C8610	FT DODGE	94	GIL CITY	*****			1/2	3
C8427	FT DODGE N	94	GIL CITY	*****			1/2	3
C8062	FT DODGE	94	GIL CITY	*****			1/2	3
C8425	FT DODGE E	94	GIL CITY	*****			1/2	3
C8638	FT DODGE	94	GIL CITY	*****			1/2	3
C8533	FT DODGE	94	GIL CITY	*****			1/2	3
C8780	FT DODGE	94	GIL CITY	*****			1/2	3
C8403	FT DODGE	94	GIL CITY	*****			1/2	3
C9005	FT DODGE	94	GIL CITY	*****			1/2	3

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WENDELL DUBBERKE 1-515-296-1339 IOWA DOT AMES, IOWA

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LABNO QUARRY	CO UNIT	00	10	20	30	40	50	60	70	80	SIZE/BED/SERV
C8428 FT DODGE	S 94	GIL CITY	*****	.							1/2 3
C8578 FT DODGE	94	GIL CITY	*****	.							1/2 3
C8347 FT DODGE	94	GIL CITY	*****	.							1/2 3
C8036 FT DODGE	94	GIL CITY	*****	.							1/2 3
C6011 FT DODGE	94	GIL CITY	*****	.							1/2 3
C9689 YATES	94	ST LOUIS	*****	.							1/2 2-10 ?
C8140 ANDERSON	96	STEWARTVLE	*****	.							1/2 2
C8622 ANDERSON	96	STEWARTVLE	*****	.							1/2 3
C8237 ANDERSON	96	STEWARTVLE	*****	.							1/2 3
C8666 NORTHWOOD	98	CORALVILLE	*****	.							1/2 MINN 3
C8480 NORTHWOOD	98	CORALVILLE	*****	.							1/2 3
C8663 NORTHWOOD	98	CORALVILLE	*****	.							1/2 COMM 3
C8666 NORTHWOOD	98	CORALVILLE	*****	.							1/2 MINN 3
C8478 NORTHWOOD	98	CORALVILLE	*****	.							1/2 3
C8479 NORTHWOOD	98	CORALVILLE	*****	.							1/2 3
C8664 NORTHWOOD	98	CORALVILLE	*****	.							1/2 COMM 3
C8667 NORTHWOOD	98	CORALVILLE	*****	.							1/2 MINN 3
C8477 NORTHWOOD	98	CORALVILLE	*****	.							1/2 3
C8665 NORTHWOOD	98	CORALVILLE	*****	.							1/2 COMM 3
C8665 NORTHWOOD	98	CORALVILLE	*****	.							1/2 6-7 3
C8653 NORTHWOOD	98	CORALVILLE	*****	.							1/2 RERUN 3
C8660 NORTHWOOD	98	CORALVILLE	*****	.							1/2 RM 3
C8662 NORTHWOOD	98	CORALVILLE	*****	.							1/2 RM 3
C8661 NORTHWOOD	98	CORALVILLE	*****	.							1/2 RM 3
C8653 NORTHWOOD	98	CORALVILLE	*****	.							1/2 3
C8298 RANDALL	98	CORALVILLE	*****	.							1/2 3
C8462 FERTILE	98	CORALVILLE	*****	.							1/2 3
C8459 FERTILE	98	CORALVILLE	*****	.							1/2 3
C8624 FERTILE	98	CORALVILLE	*****	.							1/2 3
C9045 FERTILE	98	CORALVILLE	*****	.							1/2 3